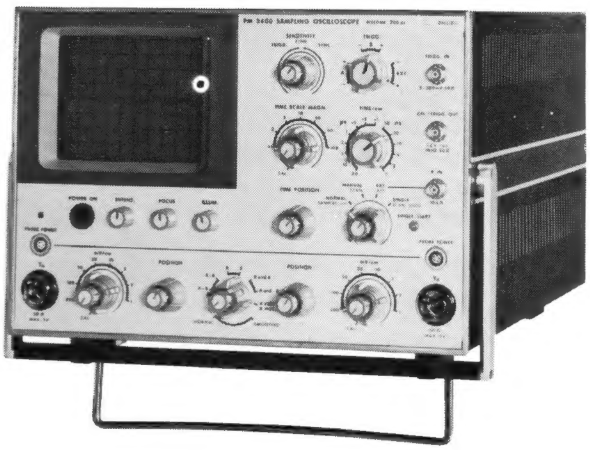
191032

PM 3400

COMPACT DUAL-TRACE
SAMPLING OSCILLOSCOPE

OPERATING MANUAL.

PHILIPS



operating manual

compact dual-trace sampling oscilloscope PM 3400

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IMPORTANT

In correspondence regarding this instrument quote the complete type number and serial number, as stated on the type plate at the rear of the instrument.

General part

I. Introduction

The PM3400 is a compact, dual-trace, sampling oscilloscope designed for a wide range of laboratory applications.
Conceived particularly with sampling techniques in mind, the oscilloscope combines fast rise times with a long-persistent c.r.t. phosphor to give optimum display with maximum detail and minimum flicker.
A bandwidth of 1.7 GHz covers the majority of circuit applications.
An important feature is the triggering circuit which provides a stable trace presentation for a variety of triggering conditions.
The instrument incorporates a rectangular, flat-faced c.r.t. with internal graticule with 10% and 90% lines, which obviates measuring errors due to parallax.
Attention to the ergonomical lay-out of the front panel controls: the PM3400 is as easy to operate as a real-time oscilloscope. Furthermore, the accessibility and logical lay-out of components give the oscilloscope a high degree of serviceability.

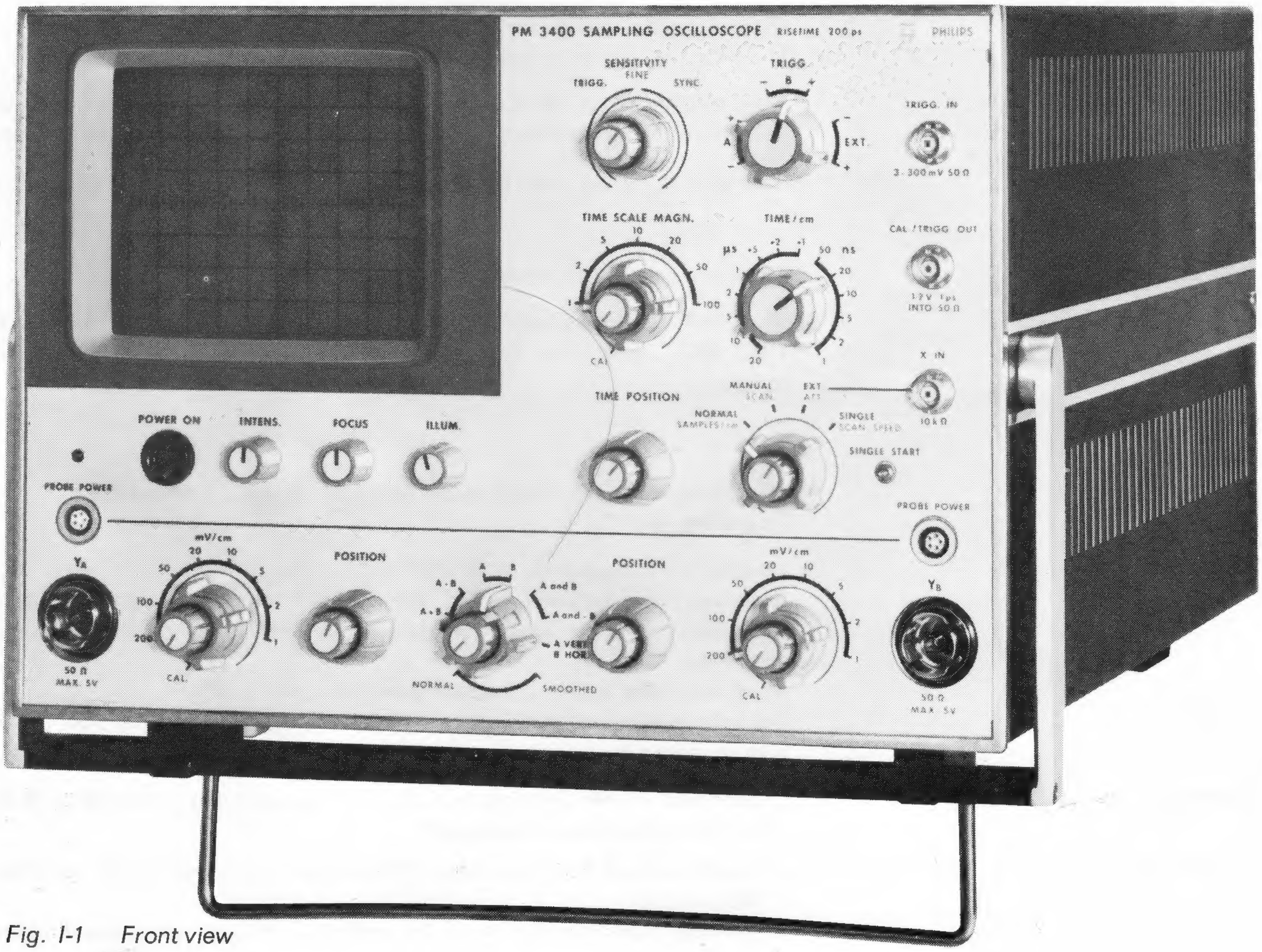

Fig. I-1 Front view

II Technical data

Y-AXIS

Two identical amplifiers (channels A and B)

Mode of operation	Channel A only Channel B only Channel A and channel B Channel A and inverted channel B Channel A plus channel B Channel A minus channel B Channel A vertical and channel B horizontal.
Bandwidth	DC to 1.7 GHz.
Rise time	200 ps ± 10%.
Overshoot	Less than 3% (with 200ps pulse generator)
Deflection coefficients	8 calibrated ranges from 1 mV/cm to 200 mV/cm in 1-2-5 sequence. A vernier provides uncalibrated, continuous control between the ranges and extends the deflection coefficient to less than 0.4 mV/cm.
Attenuator tolerance	± 3%.
Displayed noise (tangentially measured)	Less than 2 mV with NORMAL-SMOOTHED switch in NORMAL position and less than 0.8 mV in SMOOTHED position. Automatic smoothing in the 1 and 2 mV/cm ranges.
Isolation between the channels	More than 60 dB up to 1 GHz.
Input impedance	50 Ω. Input connectors: General Radio 874, locking recessed.
Signal delay	Delay time for each channel: 30 ns. Visible delay: 7 - 10 ns. The difference in delay between the channels is less than 30 ps.
Signal range	Small signals on top of DC levels up to ± 1.6 V can be displayed without distortion, at any sensitivity, +2V or —2V can be displayed at 200 mV/cm.
Position	Coarse and vernier controls provide a vertical shift of ± 1.6 V.
Maximum input voltage	± 5 V DC.
Probe power	Connectors for active probes on both channels.
Recorder outputs	Channel A, channel B and Y. Output amplitude .5 V/cm. Source resistance 1 kΩ. BNC-connectors. Zero volt level corresponds to the centre of the screen.

TIME AXIS

Time coefficients	14 calibrated ranges from 1 ns/cm to 20 μs/cm in 1-2-5 sequence. Tolerance: ± 3%.
Time scale magnification	7 calibrated ranges from x1 to x100 in 1-2-5 sequence. A vernier provides uncalibrated, continuous control between the ranges. The intensity and the sample density remain constant when the display is magnified. At all magnifier settings, the tolerance is within ± 5%. The centre of magnification is at midscreen (or at the left-hand side of the screen, depending on the position of an internal selector).
Time position	Coarse and vernier controls provide a time-positioning range equal to at least one unmagnified screen width.
X-deflection	– Repetitive from 5 to more than 1000 samples/cm, continuously variable. – Manual scan. – External scan by means of an external voltage, via a continuous

	attenuator with an input impedance of 10 kΩ. For 10 cm deflection, a minimum voltage of +6 V is required. (+0.5 V corresponds to the left-hand side of the screen). - Single scan by means of internal slow ramp voltage. The sweep time is adjustable from 5 to 60 s per sweep. One continuous control covers all these functions.
Recorder output	X OUT. Output amplitude of 0.5 V/cm. Source resistance 1 kΩ. BNC-connector. Zero volt level corresponds to the left-hand side of the screen.

TRIGGERING

Mode	Triggered or synchronized.
Source	Channel A, channel B or external source.
Slope	+ or —.
Triggering capability (the — slope generally gives less jitter than the + slope)	Internal 20 mV $_{p-p}$ to 2 V $_{p-p}$ External 3 mV $_{p-p}$ to 300 mV $_{p-p}$
Time jitte	**Pulses** Less than 30ps + 0.2% of unmagnified time/cm for pulses with a rise time ⩽ 300ps and 10 mV on the EXT-input or 100 mV for internal triggering. **Sine waves** Less than 30ps + 0.2% of unmagnified time/cm — or 1% of a period, whichever is greater —from 100 kHz to 1700 MHz, with 19 mV $_{r.m.s.}$ on the EXT-input or 100 mV$_{r.m.s.}$ for internal triggering.
Trigger kick-back	Less than 3 mV$_{peak}$ on the external trigger input connecter.
Safe overload	Maximum 3 V$_{peak}$
Trigger output	Suitable as calibration voltage. Pulse amplitude: 1.2 V ± 2% into 50 Ω. Pulse rise time: less than 4 ns. Pulse width: 1 μs ± 2%.

C.R.T.

Type	D14 - 120 GR/37 with long persistence phosphor.
Graticule	Internal, with cm-divisions and 10%- and 90%-indications for measuring rise times.
Useful screen area	8 cm x 10 cm.
Graticule illumination	Continuously variable.
Total acceleration voltage	10 kV.

POWER SUPPLY

Mains voltages	110, 125, 145, 200, 220 and 245 V.
Mains frequency	50 - 400 Hz.
Power consumption	80 VA.

TEMPERATURE RANGE

Operation within specification	0° C to +45° C.

OVERALL DIMENSIONS AND WEIGHT

Height	24.4 cm (9.61'').
Width	34.1 cm (13.41'').
Depth	53.4 cm (21.02'').
Weight	16.5 kg (36.5 lbs).

Values with specified tolerances are guaranteed bij the factory. Numerical values without tolerances represent properties of an average instrument and serve only as a guide.

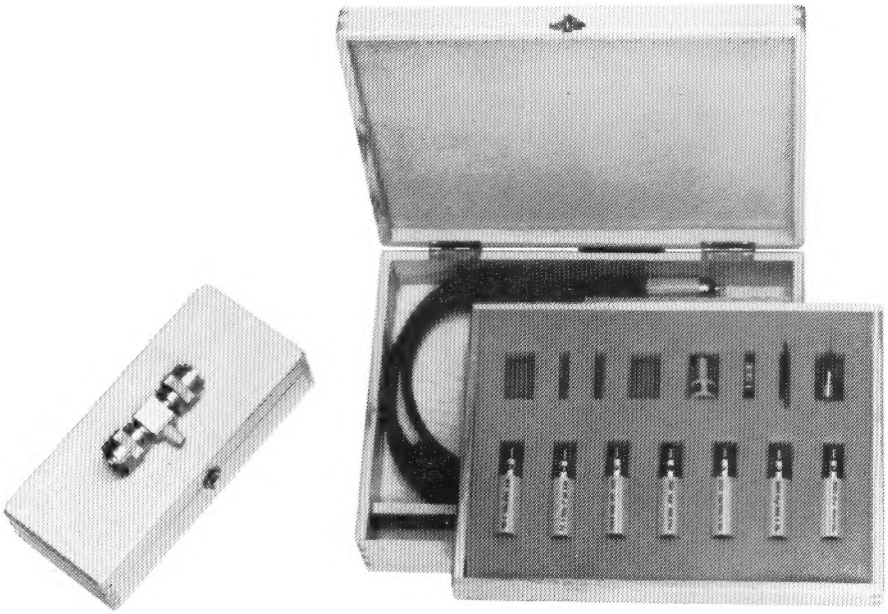

Fig. III-1 Cathode follower probe PM9345, slip-on attenuator set PM9341 and coaxial T-piece PM9344

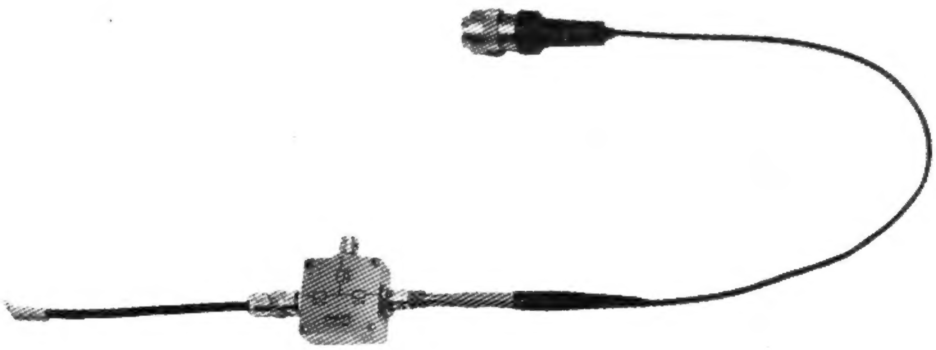

Fig. III-2 Attenuator probe

III. Accessories

Optional accessories

Slip-on attenuators	PM9341
Attenuator probe 1 : 10	PM9342
Attenuator probe 1 : 100	PM9343
Coaxial T-piece	PM9344
Cathode follower probe	PM9345
Rack mount kit	PM9364
Collapsible viewing hood	PM9366
Polaroid camera	PM9380
Supplementary lens	PM9373
Camera adapter	PM9376
Carrying case	PM9394
Trolley	PM9395

Fig. III-3 Polaroid camera PM9380

OTHER SUGGESTED ACCESSORIES

1. **Attenuators** (fixed)

Texscan Corp., FP50 BNC Outline A

Specification: Attenuation: 20dB
Freq. range: DC - 2000 MHz
Power handling capability: 1 W

General Radio GR874

Attenuation at DC (dB)	*Type*
3	874G3
	874G3L*
6	874G6
	874G6L*
10	874G10
	874G10L*
14	874G14
	874G14L*
20	874G20
	874G20L*

*Locking recessed
Specification:
Frequency range DC to 4000 MHz
Power handling capability 1 W

2. **Adaptors**

General Radio GR 874 BNC plug type 874-QBPA

Fig. III-4 Texscan 20 dB attenuator

Fig. III-5 General Radio GR874 attenuators

Fig. III-6 GR874 to BNC adapter

3. Coaxial cables

Philips coaxial cables RG58A-U with BNC connectors:

Type	*Length * (mm)*	*Delay (ns)*
4822 320 10009	200	1
4822 320 10011	400	2
4822 320 10012	600	3
4822 320 10013	1980	10

* Length without connectors

General Radio patch cords GR874 (GR-connectors)

Type	*Attenuation (dB/100 ft at 1 GHz)*
874-R20A	10.5
874-R22A	22

Fig. III-7 Coaxial patch cord General Radio 874-R20A

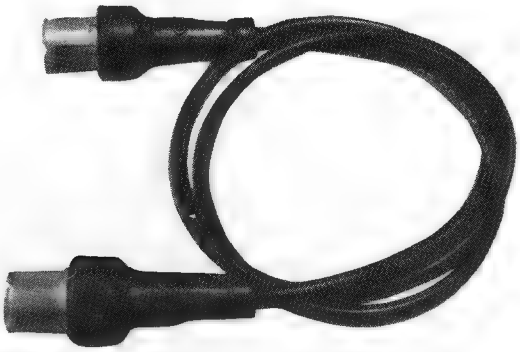

Fig. III-8 Coaxial patch cord General Radio 874-R22A

IV. Principles of operation
(Fig. IV-1)

Y-AXIS

General

The vertical system may be regarded as an error-sensing feedback system. A balanced bridge sampler is used as the error sensing element and a memory stores the amplitude of the last sample.
The output voltage of the memory is fed back to the sampling bridge. Thus, if the input signal at the moment of sampling equals the output voltage of the memory, the effective input to the bridge is zero and there will be no error signal. If, however, the input voltage differs from the output voltage, an error signal proportional to the difference is produced at the sampling bridge.
After amplification the error signal is used to correct the output voltage of the memory circuit.
In this way, the input voltage is continuously compared to the previously sampled level and, if necessary, corrections are made.

Vertical channels

The vertical deflection unit consists of two identical channels A and B and a number of circuits which are used by both channels. These common circuits are the SAMPLING PULSE GENERATOR, the DRIVER TIME DELAY circuit, the DUAL TRACE MULTIVIBRATOR and the Y OUTPUT AMPLIFIER.
As the vertical channels are identical, only channel A will be described.
The signal is applied to a 50 Ω connector P5A with a built-in trigger take-off transformer. Here part of the input voltage is tapped-off and fed to the horizontal deflection unit, where it starts the timing circuits. After a short interval the time base unit sends a strobe pulse to the sampling pulse generator. Each strobe pulse causes the sampling pulse generator to supply two very fast sampling pulses of opposite polarity, which control the opening of the sampling gate.
The minimum time required for the whole triggering process should be compensated for if the trigger point of the wave form is to be displayed. As this is required to observe leading edges of fast rising signals, a 30 ns delay line has been incorporated between the trigger take-of transformer and the sampling gate.
The high frequency losses caused by the delay line are compensated for in a passive network, before the input signal reaches the sampling gate. The sampling gate diodes are reverse biased by a bridge network. The d.c. level of the bridge and so the vertical position of the trace, can be changed with controls RV11-RV12 (POSITION), via the positioning amplifier. When the sampling gate is opened by the output pulses of the sampling pulse generator, a capacitor is charged to a voltage proportional to the difference between the input signal level at the moment of sampling and the voltage level established by the previcus sampling.
The change in voltage across the capacitor will be referred to as the correction sampling pulse. This pulse is then amplified in a charge amplifier (the preamplifier), which compensates for the signal that passes the capacitance of the sampling diodes when they are reverse-biased.
From the preamplifier the signal is applied to a selective amplifier, which is tuned to approximately 700 kHz. Switch S7A (mV/cm) controls the gain of the amplifier.
A pulse from the COMPARATOR also starts a time delay circuit. The delayed pulse from the latter starts a pulse width circuit, in the block diagram labelled MEMORY GATE DRIVER. When the MEMORY GATE opens, the correction sample pulse is passed into the MEMORY. The memory stores the signal voltage till the next sampling. The output of the memory is fed back to the output of the sampling gate via feedback attenuator S7A and the bridge network for diode biasing. When adjusting the gain of the amplifier with S7A (mV/cm), a corresponding attenuation of the feedback signal will take place.
Switch S9 (NORMAL/SMOOTHED) controls the loop gain. In position NORMAL the loop gain is unity. In position SMOOTHED the loop gain is decreased so that random noise is suppressed.
The output voltage of the memory is also applied to the switching diodes via a differential amplifier. The sensitivity of this amplifier is continuously adjusted with potentiometer RV10A (mV/cm, VARIABLE).
The delayed pulse supplied from the DRIVER TIME DELAY circuit also triggers a bistable multivibrator, in the block diagram labelled DUAL TRACE MULTIVIBRATOR. The output pulses from this multivibrator control the switching diodes, which direct the signals from the A and B channels to the Y output amplifier. Different combinations of the A and B channels are selected with switch S8 (VERTICAL MODE).

TIME-AXIS

The part of the vertical input signal which is tapped-off by the trigger take-off transformer, is supplied to the trigger circuits via trigger selector switch S1. Via this switch also a trigger signal from an external source can be applied to the trigger circuits through socket P1 (TRIGG. IN).
The trigger signal is fed to an amplifier and a regenerator circuit, the latter consisting of a tunnel diode multivibrator. Triggered or synchronised mode is selected with RV1 (SENSITIVITY) and vernier RV2. Furthermore the trigger level and the synchronisation frequency are continuously adjustable with RV1 and RV2. The trigger memory and the hold-off circuit limit the sampling frequency to approximately 100 kHz.
The duration of the hold-off time is determined by the setting of switch S3 (TIME/cm).
A pulse voltage from the hold-off circuit triggers a pulse generator. This generator provides a well-defined pulse voltage at output socket P2 (CAL./TRIGG OUT) on the front panel.

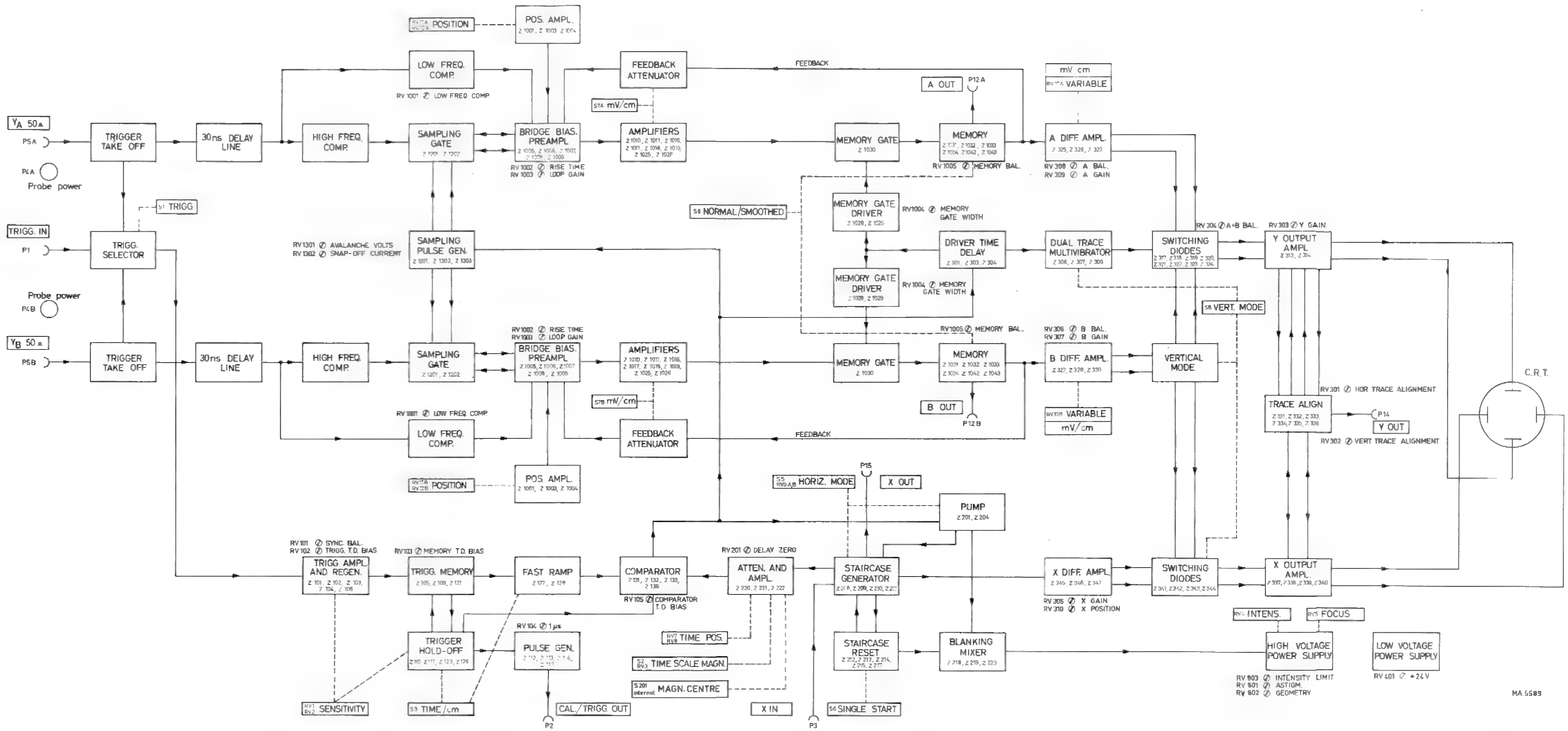

Fig. IV-1 Block diagram

The hold-off circuit also supplies a bias current to the tunnel diode in the comparator stage.
The pulses from the trigger memory start a ramp generator. The slope of the ramp voltage is determined by the position of switch S3 (TIME/cm). This ramp voltage is applied to the comparator stage, where it is compared with a staircase voltage supplied by a staircase generator. When the ramp voltage equals the staircase voltage the comparator supplies a strobe pulse, which is fed to the sampling pulse generator, to the time delay circuit for the memory gate driver and finally to the pump circuit.
Triggered by a strobe pulse, the pump circuit supplies a pump pulse to the staircase generator, causing the latter to make one step.
Thus the staircase voltage is built up step by step. The height of each step is adjustable with control RV9A (SAMPLES/cm). As the sweep length is constant, the number of steps per sweep and consequently the number of samples per cm can be changed in this way. After attenuation and amplification, the staircase voltage is supplied to the comparator.
The staircase voltage is shifted by means of controls RV7, RV8 (TIME POS.) in such way that the trace can be moved in horizontal direction. By means of controls S2, RV3 (TIME SCALE MAGN.) the staircase voltage is attenuated, so that the time scale is magnified. Different deflection modes can be selected by means of controls S5, RV9 (HORIZ. MODE).
At the end of the sweep, the staircase generator is reset by the staircase reset stage. Simultaneously, a blanking pulse is fed to the blanking mixer and further to the CRT via the high voltage power supply. Thus, blanking between each sweep is accomplished. The pump circuit also supplies pulses to the blanking mixer. These pulses are used for blanking between each sample.
Output P15 (X OUT) supplies a horizontal deflection voltage for use in external devices such as recorders. An external horizontal deflection voltage can be applied to input P3 (X IN). Then the staircase generator is disconnected.
The staircase voltage is applied to the X differential amplifier, the outputs of which are connected to the X output amplifier via the switching diodes. With switch S8 (VERT. MODE) the signal from the B channel can be supplied to the X output amplifier, while the normal X deflection voltage is disconnected.

TRACE ALIGNMENT

To align the X trace with the horizontal axis of the internal graticule of the CRT, part of the X signal is added to the Y signal in the Y output amplifier, via the trace alignment stage.
Similarly, the Y trace is aligned with the vertical axis of the internal graticule by adding part of the Y signal to the X signal in the X output amplifier.
From the trace alignment unit, a Y signal for external use can be taken out via socket P14 (Y OUT).

HIGH AND LOW VOLTAGE POWER SUPPLY

These blocks provide the high voltage supply for the CRT and the low voltage supply for the remaining circuits.

Directions for use

V. Installation

A. POSITIONING THE INSTRUMENT

Always place the instrument so that the air circulation along the sides and the rear is not impeded. The instrument will otherwise not be properly cooled.
The ambient temperature may not exceed 45° C.

B. ADJUSTING TO THE LOCAL MAINS VOLTAGE

The instrument can be adapted to local mains voltages of 110-125-145-200-220-245 V using a voltage adapter.

The set voltage can be read through the aperture in the plastic lid on the rear panel (Fig. V-2).

Adjustment to another mains voltage is effected as follows:

- Remove the plastic lid on the rear panel.
- Pull out the voltage adapter.
- Turn the adapter until the desired voltage is topmost and press it in again.
- Refit the plastic lid.

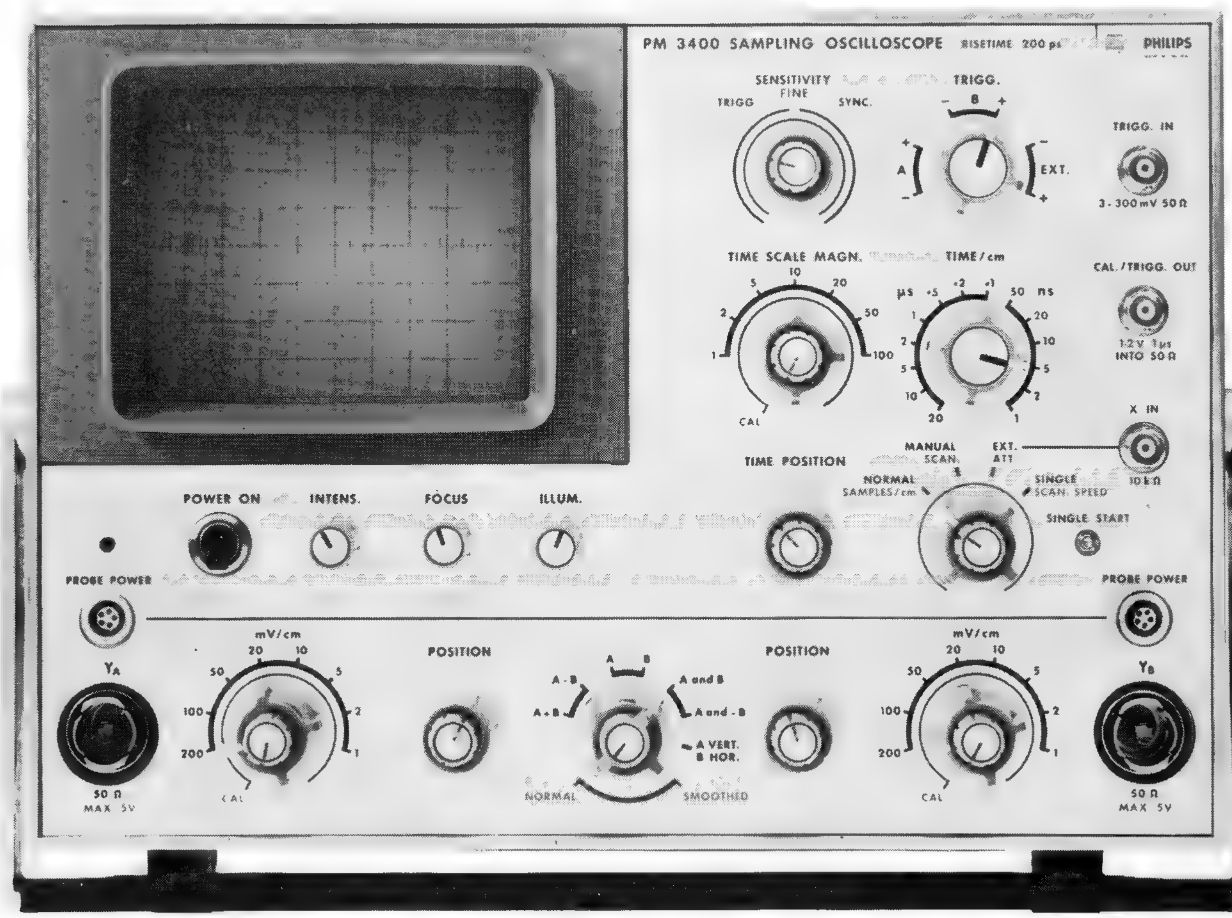

Fig. V-1 Front view

C. EARTHING

The instrument should be earthed in accordance with the local safety regulations. This can be effected as follows:

a. Via the mains flex. The instrument is provided with a 3-core mains flex.
b. Via the earthing socket P13 on the rear panel (Fig. V-2)
AVOID DOUBLE EARTHING!

D. CONNECTION TO THE MAINS AND SWITCHING ON

- Check that the voltage adapter is in the correct position.
- Earth the instrument.
- Connect the instrument to the mains.
- Set the mains switch to "POWER ON". (Fig. V-1)
- The pilot lamp should light up.

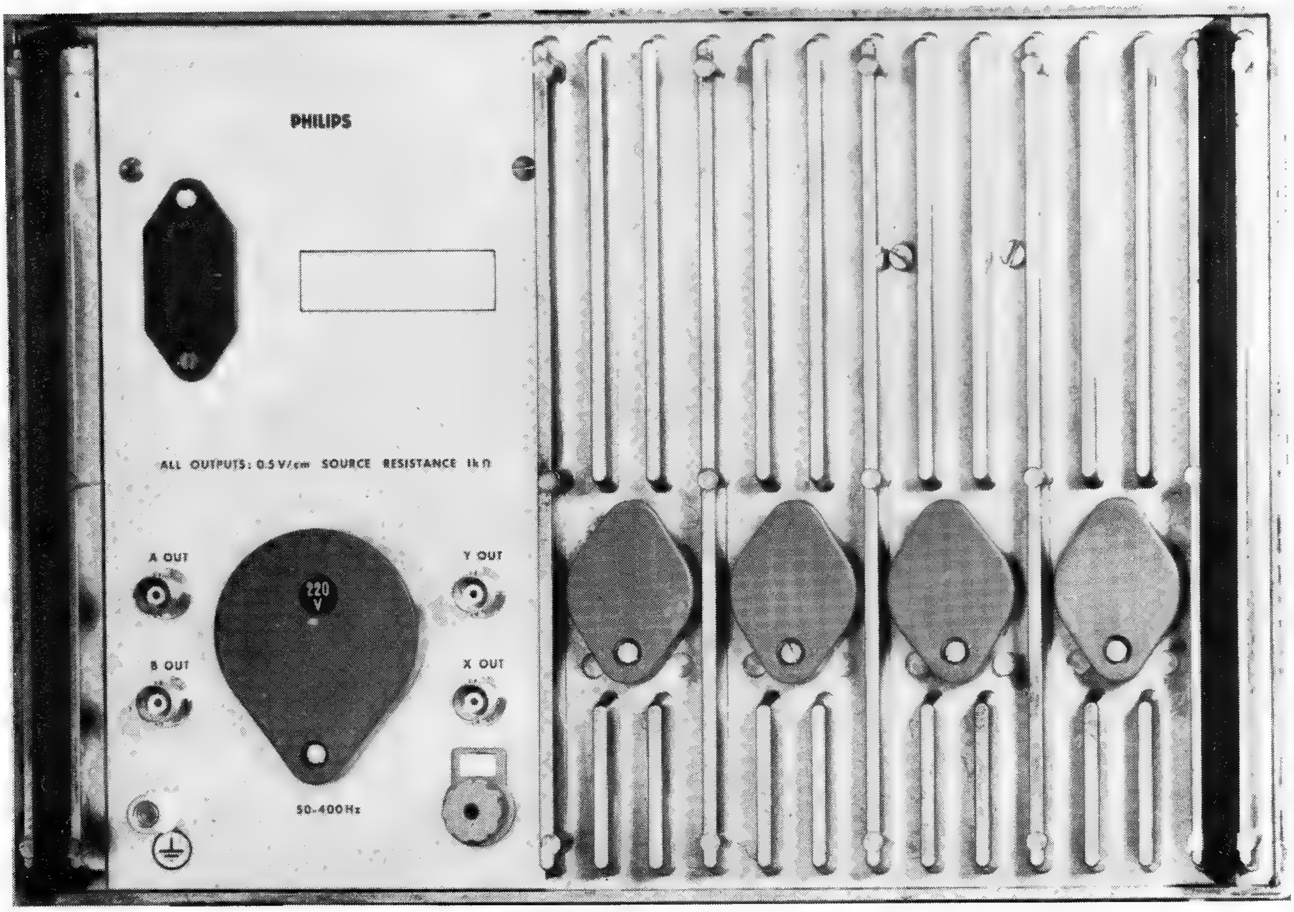

Fig. V-2 Rear view

VI. Controls, input and output sockets

Y-AXIS (Fig. VI-1)

Control or socket	Designation	Purpose
P5A	Y_A	Input connecter for channel A
S7A	mV/cm	Step control of the deflection coefficients of channel A
RV10A	mV/cm	Uncalibrated, continuous decrease of the deflection coefficients with a range of at least 0.4 to 1
RV11A-RV12A	POSITION	Coarse and fine control of the vertical position of the channel A display
S8	A+B A—B A B A and B A and —B A VERT. B HOR.	Mode switch for the selection of A and/or B channels in different combinations. It is also possible to use the A channel for vertical and the B channel for horizontal deflection
S9	NORMAL/SMOOTHED	Smoothing of the random noise in both channels
RV11B-RV12B	POSITION	Coarse and fine control of the vertical position of the channel B display
S7B	mV/cm	Step control of the deflection coefficients of channel B
RV10B	mV/cm	Uncalibrated, continuous decrease of the deflection coefficients with a range of at least 0.4 to 1
P5B	Y_B	Input connecter for channel B

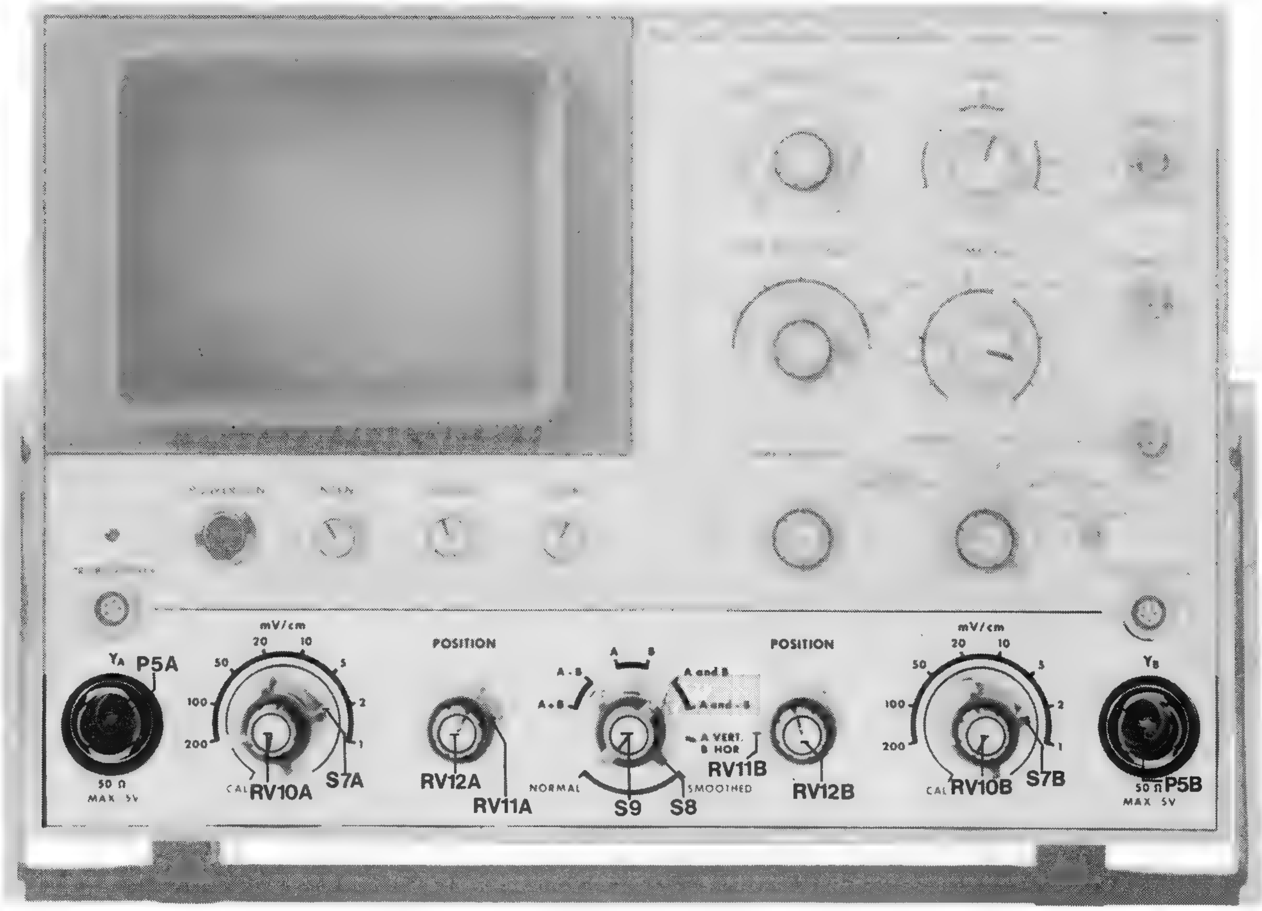

Fig. VI-1 Controls and sockets Y-AXIS

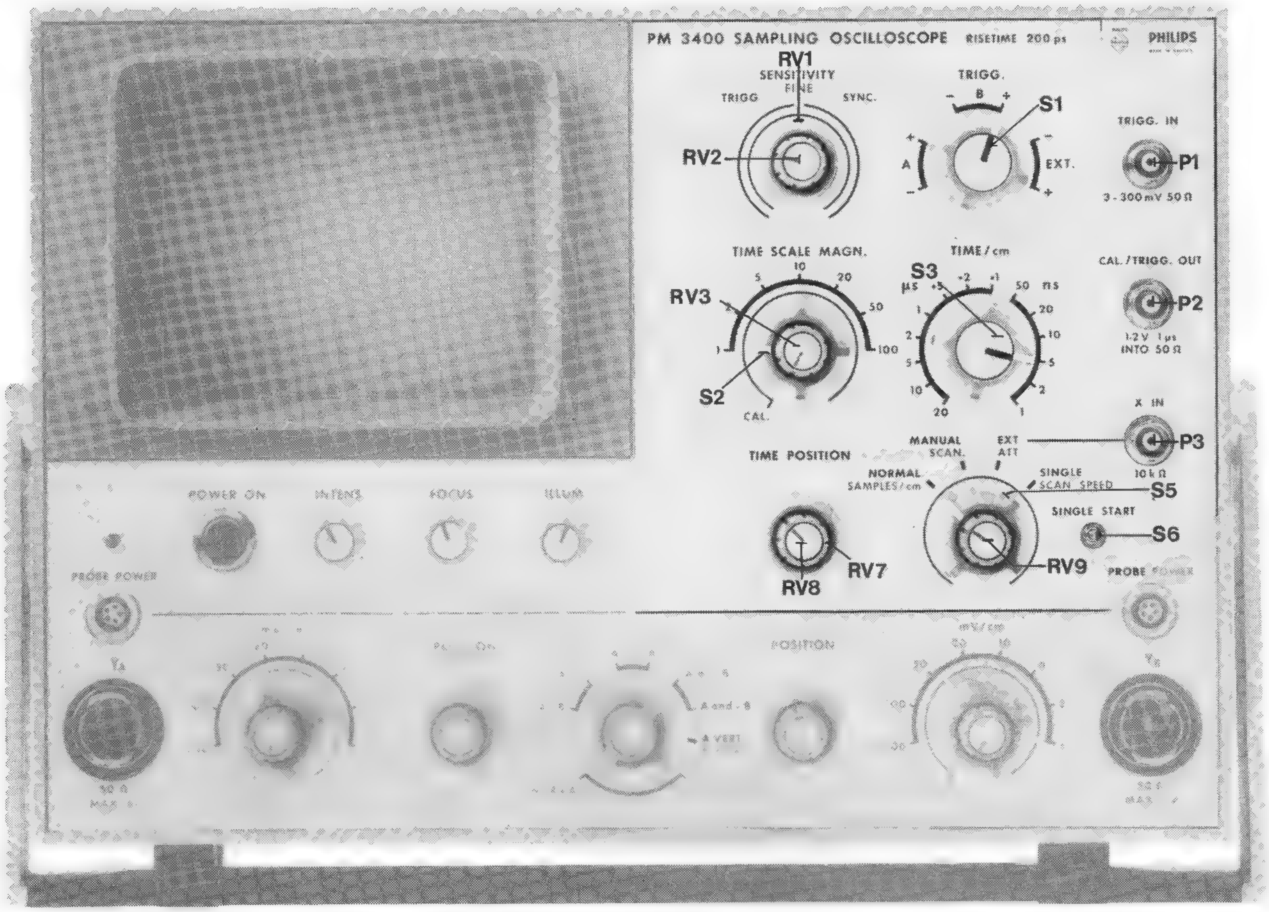

Fig. VI-2 Controls and sockets TIME AXIS

TIME AXIS (Fig. VI-2)

Control or socket	Designation	Purpose
RV1	SENSITIVITY	Continuous adjustment of triggering or synchronising levels
RV2	FINE	Vernier for RV1
S1	TRIGG., ±A, ±B, ±EXT	Selection of trigger slope and trigger signal to the time base unit
P1	TRIGG. IN	Input socket for external trigger signals
S2 RV3	TIME SCALE MAGN.	Step increase of the time coefficients up to 100 times Fine adjustment of the time coefficients
S3	TIME/cm	Selection of the time coefficients between 1 ns/cm and 20 μs/cm
P2	CAL./TRIGG. OUT	Output socket providing a pulse voltage for triggering of external devices or for calibration purposes
RV7 RV8	TIME POSITION	Coarse and fine adjustment of the time position of the signal
S5		Selection of the type of deflection
	NORMAL	Normal deflection from the internal source
	MANUAL	Manual deflection
	EXT	Deflection from an external source
	SINGLE	Single shot deflection (with the aid of push button S6)
RV9		Depending on the position of S5
	SAMPLES/cm	When S5 occupies position NORMAL, the number of samples per centimetre can be continuously varied between 5 and more than 1000
	SCAN	When S5 occupies position MANUAL, RV9 can be used for manual scanning
	ATT	When S5 occupies position EXT., the signal of the external time base source can be attenuated by means of RV9
	SCAN SPEED	When S5 occupies position SINGLE, the scanning speed can be adjusted by means of RV9
S6	SINGLE START	Push button for starting the single sweep when S5 occupies position SINGLE. The sweep starts as soon as the push button is depressed.
P3	X IN	Input socket for a deflection voltage from an external source

DISPLAY (Fig. VI-3)

Control or socket	Designation	Purpose
RV4	INTENS	Control for the brightness of the display
RV5	FOCUS	Control for the focussing of the electron beam
RV6	ILLUM	Control for the illumination of the internal graticule

POWER SUPPLY (Fig. VI-4)

Control or socket	Designation	Purpose
S4	POWER ON	Mains switch
P4A	PROBE POWER	Power output socket intended for active measuring probes (channel A)
P4B	PROBE POWER	Power output socket intended for active measuring probes (channel B)

Fig. VI-3 Controls and sockets DISPLAY

Fig. VI-4 Controls and sockets POWER SUPPLY

CONTROLS AND SOCKETS ON THE REAR OF THE INSTRUMENT (Fig. VI-5)

Control or socket	Designation	Purpose
P11		Mains connecter
P12A	A OUT	Output socket providing a signal from the A channel for external use
P12B	B OUT	Output socket providing a signal from the B channel for external use
P13	⏚	Earth connecter
P14	Y OUT	Output socket providing a Y deflection voltage for external use
P15	X OUT	Output voltage providing an X deflection voltage for external use
S11		Mains voltage selector

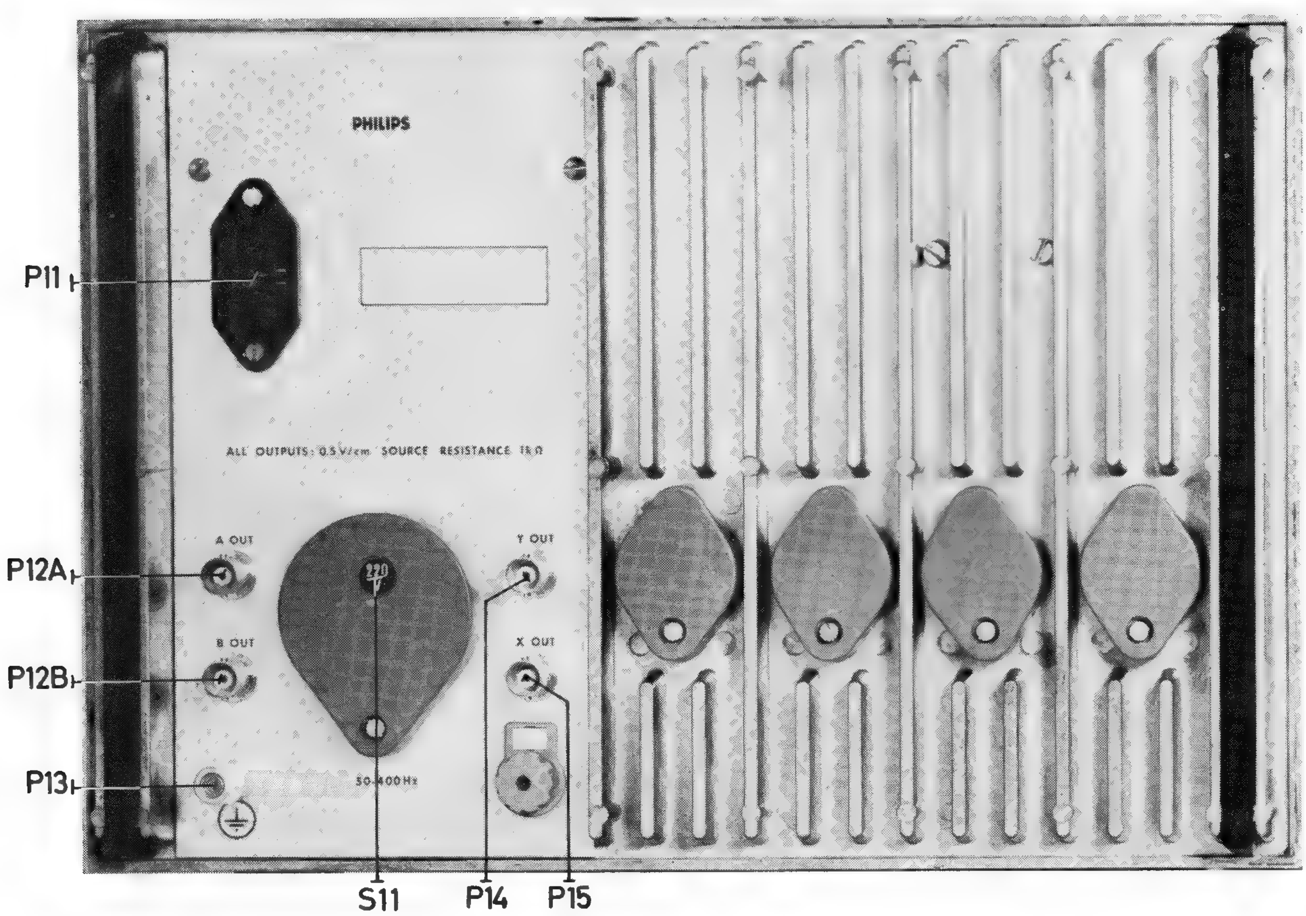

Fig. VI-5 Controls and sockets on the rear of the instrument

VII. OPERATION

A. PRELIMINARY ADJUSTMENTS

1. Displaying a signal

- Switch on the instrument
- Set SENSITIVITY knob RV1 to the SYNC mode
- Set INTENSITY knob RV4 to mid position
- Set horizontal mode switch S5 to NORMAL, and turn knob RV9, SAMPLES/cm, to mid-position.
- Set switches S7A and B to 200 mV/cm
- Set knobs RV11A and B to mid position
- Set vertical mode switch S8 to position A and B.
- Two traces should now be visible on the screen.
- Set switch S8 to position A so that trace B disappears.
- Connect a signal from a pulse generator via a 50 Ω coaxial cable to input Y_A (amplitude 100 mV - 1 V, repetition time 200 ns-1 μs, rise time approximately 20 ns).
- Set TRIGG. selector S1 to A+ or A—, depending on the slope of the input signal.
- Set switch S2, TIME SCALE MAGNIFIER, to 1.
- Set switch S3, TIME/cm, to 5 ns/cm.
- Turn knob RV7, TIME POSITION, fully clockwise.
- Set switch S9, NORMAL/SMOOTHED, to NORMAL.
- Turn RV1, SENSITIVITY, in counter-clockwise direction until a stable display is obtained.

Measuring the rise time of the displayed pulse

- Position the display to the centre of the screen by means of RV11A, POSITION (see Fig. VII-1).
- Magnify the display vertically using S7A, mV/cm, and its vernier RV10A. (see Fig. VII-2).
- Readjust, if necessary, the vertical position by means of RV11A, POSITION, and vernier RV12A.
- Set switch S3, TIME/cm, to a suitable time coefficient.
- Position the pulse edge to the centre of the screen by means of knob RV7, TIME POSITION.
- The rise time should cover at least 3 cm of the horizontal scale to ensure accurate measurement (see Fig. VII-3).
- If, necessary, magnify the display by switching S2, TIME SCALE MAGNIFIER, to a higher position. The display is then magnified around the centre of the screen.
- The 10% and 90% levels are indicated by two dotted lines in the internal graticule.

2. Measuring accessories

For the technical data of the accessories available, see chapter III, ACCESSORIES.

B. TIME POSITION

The TIME POSITION control consists of two knobs. RV7 (coarse control) and RV8 (fine control).
The sweep always starts at the left-hand side of the screen.

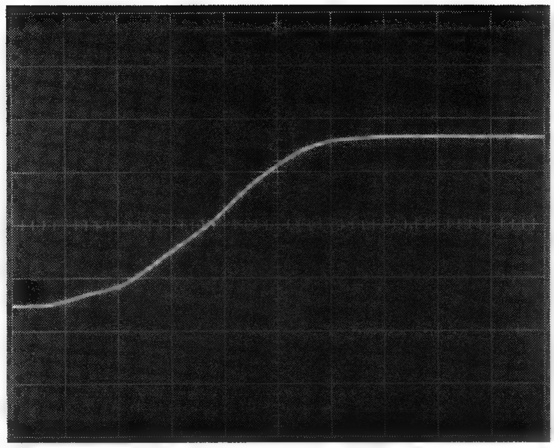

Fig. VII-1 Measuring rise times

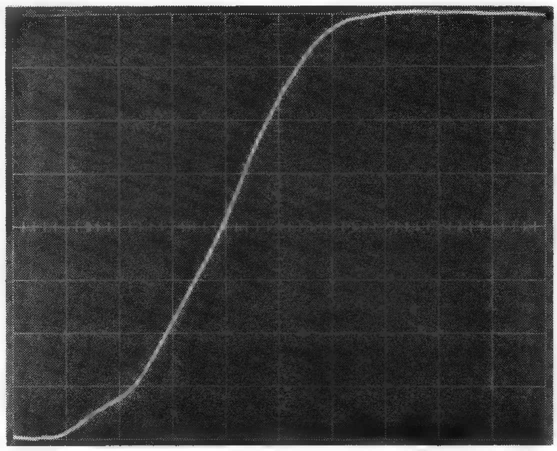

Fig. VII-2 Measuring rise times

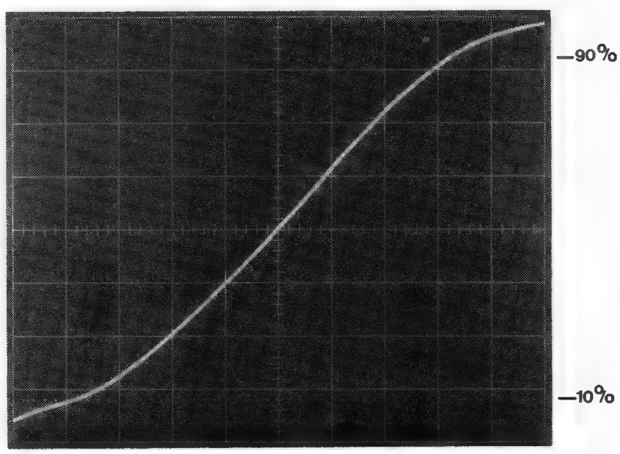

Fig. VII-3 Measuring rise times

When both controls are in the fully clockwise position the trigger edge is in the most right hand position and it should then always be visible, assumed that the time scale is not magnified. The trigger edge moves to the left when the TIME POSITION controls are turned in anti-clockwise direction.

C. TIME COEFFICIENT

The time coefficient is selected with the switch S3, TIME/cm. The time scale can be enlarged up to 100× by means of the control S2, TIME SCALE MAGN.
The time coefficient is equal to the quotient of the TIME/cm switch setting and the setting of the TIME SCALE MAGNIFIER switch. The time coefficient can be continuously varied by means of the vernier RV3. The time coefficients are calibrated in the CAL. position of this vernier only.
It should be noted that the apparent beam speed across the c.r.t. screen is not equal to the actual time coefficient indicated.
If the time scale is to be magnified, first position the significant part of the display in the middle of the screen. When turning the control S2, TIME SCALE MAGN., that part of the display which is situated in the middle of the screen stays there during the magnification. The magnification centre can be moved to the left of the screen by means of the internal switch S201 (on circuit board 2).
The switch can be operated through an aperture in the right-hand side of the housing. See Fig. VII-4.

NOTE: Before switching over to magnification using the TIME SCALE MAGNIFIER switch, first set to as short a time coefficient as possible with the TIME/cm switch. Then bring the part to be magnified to the centre of the screen using the TIME POSITION control.

The table below facilitates the understanding of the TIME SCALE MAGNIFICATION control on PM 3400. The table is made for the normal situation of magnification around the centre of the screen.

Time coeff. ns/cm	Time scale magnifier	Resulting time coeff. ns/cm	Range on the screen	Available "sweep" cm	Available time ns
1	1	1	0-10	20	20
1	2	0.5	2.5-7.5	30	15
1	5	0.2	4-6	60	12
1	10	0.1	4.5-5.5	110	11
1	20	0.05	4.75-5.25	210	10.5
1	50	0.02	4.9-5.1	510	10.2
1	100	0.01	4.95-5.05	1010	10.1

Occasionally it is advantageous to magnify around the beginning of the sweep. Such a case is for instance when one wants to use a long time coefficient and not loose the first part (as 20 ns/cm). The first five cm:s are then available up to the full magnification of 100 times.

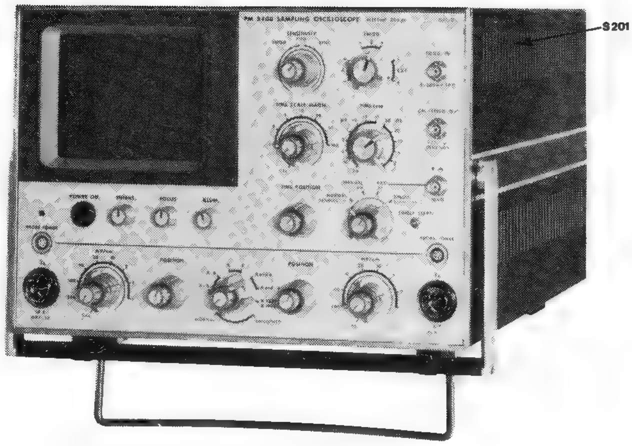

Fig. VII-4 Position of switch S201

D. S8 VERTICAL MODE

Any one of seven operation modes may be chosen using the vertical mode selector S8.

"A"	Only the input signal of channel A is displayed.
"B"	Only the input signal of channel B is displayed.
"A and B"	Both input signals are displayed simultaneously.
"A and —B"	Both input signals are displayed simultaneously, the polarity of signal B being inverted.
"A + B"	The signals of channels A and B are added.
"A — B"	The signals of channels A and B are added, the polarity of signal B being inverted.
"A VERT. B HOR."	The input signal of channel B is used for horizontal deflection. Switch S7B, mV/cm, now determines the horizontal sensitivity. The picture can be shifted horizontally using control RV11B POSITION.

E. TRIGGERING

Internal or external triggering mode can be selected with the switch S1 TRIGG.
Using internal triggering, the trigger signal is derived from the input signal to be tested, which must in this case have an amplitude of at least 20 mV_{p-p}. Using external triggering, a trigger signal of at least 3 mV_{p-p} is applied to socket P1, TRIGG. IN. The positive or negative slope of the input signal or the trigger signal may be used for triggering.

F. SENSITIVITY

PM 3400 has got a double knob as SENSITIVITY control. The bigger knob RV1 is the coarse control, which normally is sufficient to get a stable display. Sometimes a small correction with the inner knob, RV2 is needed.

The oscilloscope operates either in triggering mode or in synchronizing mode depending on the position of the coarse SENSITIVITY control. Settings to the left of 12 o'clock give triggering and are mainly used in pulse work. The inner knob will in this mode affect the sampling rate and can avoid interference phenomena. To the right of 12 o'clock the sweep freeruns in the absence of an input signal but can be synchronized if a signal is applied. This mode is mainly used for frequencies above 30 MHz. The – slopes of the TRIGG. selector give the lowest jitter at the highest frequencies.

G. THE HORIZONTAL MODE CONTROLS S5 AND RV9

1. NORMAL (S5), SAMPLES/cm (RV9)

In this position of S5 the beam is deflected by the internal staircase generator. Using knob RV9, the number of samples/cm is continuously variable from 5 samples/cm to more than 1000 samples/cm. When applying a signal with low repetition frequency, a low sampling density is required to reduce the flicker.

LF-synchronization

When switch S5 is set to position NORMAL, a signal of + 1 V applied to P3, X IN, will inhibit the start of the sweep. This can be used to synchronize on the modulating signal of an amplitude modulated RF signal. Knob RV9, SAMPLES/cm, controls the sweep speed.

It is possible to synchronize on frequencies between 10 Hz and 10 kHz. Due to the wide bandwidth of the oscilloscope the carrier is not attenuated, so it is feasible to makereliable measurements.

Proceed as follows to display the AM signal:
- Apply the modulated signal to P5A (or B).
- Apply the modulating signal to P3, X IN (amplitude $\geqslant$ + 1 V).
- Set switch S8 to position A (or B).
- Set switch S1, TRIGG., to position EXT.
- Turn knob RV1, SENSITIVITY, fully clockwise.
- Set switch S3, TIME/cm, to $\leqslant$ 0.2 μs/cm.

Note: The controls TIME POSITION, TIME SCALE MAGN. and TIME/cm are now out of function. The sweep speed is controlled by RV9, SAMPLES/cm.

Figs. VII-5 and 6 show examples of displaying AM signals.

2. MANUAL (S5), SCAN. (RV9)

In this position the horizontal deflection of the beam is controlled by knob RV9.

This mode is used when recording oscillograms on X-Y recorders and when making accurate amplitude measurements.

3. EXT. (S5), ATT. (RV9)

When S5 is set to this position, the beam is deflected horizontally by an external voltage applied to input socket P3, X IN. This voltage can, for instance, be derived from an X-Y recorder. The X input signal is attenuated by RV9.

4. SINGLE (S5), SCAN. SPEED (RV9)

The single shot may be used for photographing displays and for recording oscillograms on X-Y recorders. The scanning speed is controlled by RV9.

The sweep starts when button S6, SINGLE START, is depressed. The beam does not fly back if the button is kept depressed.

In some cases this may be used to prevent damages to the recorder stylus caused by the fast flyback.

NOTE: This single shot mode still requires a repetitive rate of the input signal.

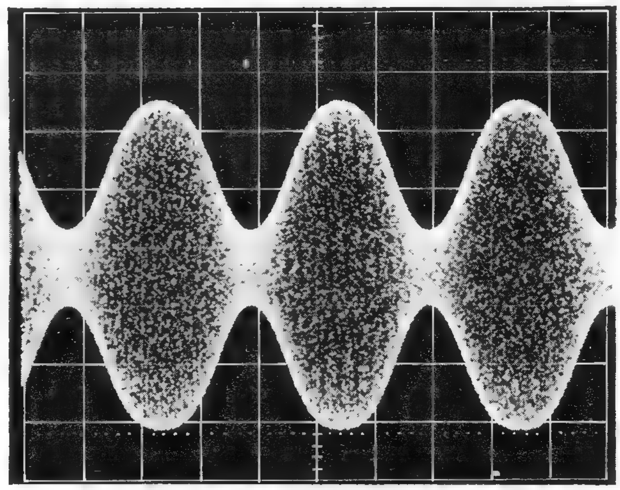

Fig. VII-5 Displaying AM-signals, LF = 1000 Hz, CW = 200 MHz

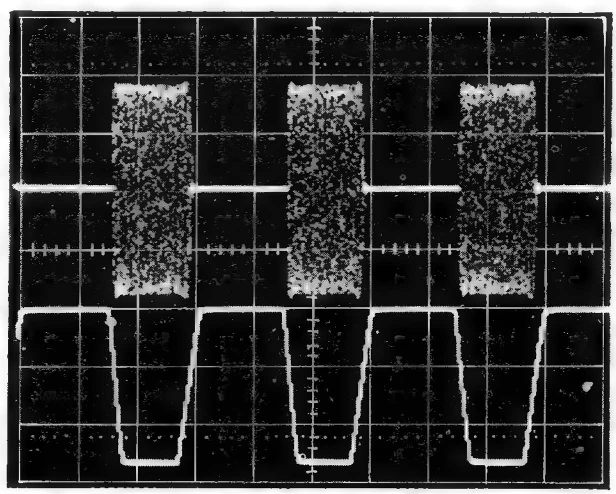

Fig. VII-6 Displaying AM-signals, pulse = 1 kHz, CW = 2 GHz

H. NORMAL/SMOOTHED

In normal amplifier techniques, the signal-to-noise ratio can be improved by decreasing the bandwidth. In a sampling oscilloscope noise suppression is possible without reduction of bandwidth.

In the "smoothed" position the loop gain is reduced to approx. 0.3, which means that more than one sample is required before the final value is reached. Since noise has a random character in contrast to the signal to be measured, the noise averages out over a large number of samples. The signal-to-noise ratio is thus improved by approximately a factor of 3.
Also the time jitter is improved when smoothing is introduced.

If the samples on the input signal are taken with a high density then the amplitude change is very small between two subsequent samples. Therefore the smoothing and, thus, noise reduction, can be introduced without affecting the signal shape. If, however, the signal is changing rapidly between two samples, which can occur if the sampling density is too low or if a step is viewed on a long time scale, then the step will appear as rounded.
It is therefore good practice to choose Time/cm and Samples/cm in such a way that amplitude changes between samples are small enough to have negligible effect on the signal shape. The influence can simply be checked by switching between Normal and Smoothed. Used in the proper way the smoothing of the noise can be very helpful, when viewing low level signals.

A special smoothing circuit is used in PM 3400 eliminating the troublesome phenomenon of base line shift, when switching from Normal to Smoothed. Fig. VII-7 shows a good example of correctly applied smoothing. The photo is a double exposure in switch positions Normal and Smoothed.
Some smoothing is automatically introduced in the most sensitive positions. The smoothing factor is 2.5 in the 2 mV/cm position and 5 in the 1 mV/cm position.

J. INPUT CIRCUIT
The input impedance of the vertical deflection system is 50 Ω, the dynamic range is 1.6 V, and the maximum input voltage is ± 5 V d.c.
If the input voltage is higher than 1.6 V any commercially available coaxial attenuator with a characteristic impedance of 50 Ω may be used (see chapter III, Accessories).
If a higher input impedance is required, an attenuator probe (PHILIPS PM 9342 or PM 9343) or a cathode follower probe (PHILIPS PM 9345) can be used. The latter should be combined with one of the available slip-on attenuators (PHILIPS PM 9341) and, if necessary, a slip-on coupling capacitor. Power for the cathode follower probes is supplied from socket P4A and/or P4B, PROBE POWER.
The cathode follower probe allows an input impedance of 10 MΩ to be obtained at a low input capacitance.

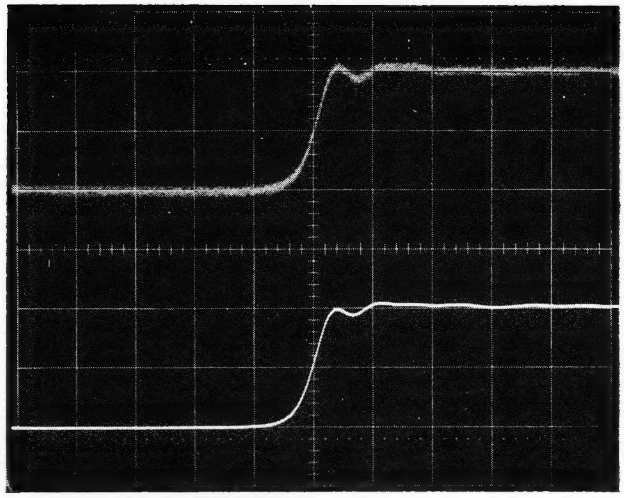

Fig. VII-7 Influence of NORMAL/SMOOTHED-switch

K. CAL./TRIGG. OUTPUT
The voltage from this output (P2) can be used for:
- Amplitude calibration
- Time calibration
- Calibration of the low frequency compensation *
- Checking and adjusting the internal loop gain *
- Triggering of external devices

* See service manual, CHECKING AND ADJUSTING

For amplitude and time calibration, proceed as follows:

- Connect the output P2 via a 50 Ω coaxial cable to P5A or P5B (Y_A or Y_B).
- Turn RV1, SENSITIVITY, to the SYNC. position.
- Set S2, TIME SCALE MAGNIFIER, to 1, and RV3, vernier, to CAL.
- Set S3, TIME/cm, to 0.2 μs/cm.
- Set S5 to NORMAL and RV9, SAMPLES/cm, to mid-position.
- Turn RV7-RV8, TIME POSITION, fully clockwise.
- Set S8 to A (or B).
- Set S9, NORMAL/SMOOTHED, to NORMAL.
- Set S7A or B to 200 mV/cm, and the vernier RV10A or B to CAL.
- Position the display by means of the knobs RV7-RV8, TIME POSITION, and RV11A-RV12A or RV11B-RV12B, POSITION, so that measuring is convenient.

The pulse amplitude is 1.2 V ± 2% corresponding to 6 cm on the screen. The pulse width is 1 μs ± 2% corresponding to 5 cm on the screen. Detailed instructions for calibration are given in the Service Manual, "CHECKING AND ADJUSTING".

L. RECORDER OUTPUTS
The Y channel of an X/Y or Y/T recorder can be connected to the output sockets P12A, A OUT, P12B, B OUT or P14, Y OUT (See Fig. VI-5). The source resistance of these outputs is 1 kΩ. The amplitude of output P14, Y OUT, is 0.5 V/cm. The voltage of P12A and

P12B is 0.5 V/cm only when verniers RV10A and RV10B are set to the CAL. position.
The X channel of the X/Y recorder should be connected to the socket P15, X OUT.

The T voltage of the Y/T recorder should be connected to the socket P3, X IN. The switch S5 should then be set to the EXT. position. The T voltage can be attenuated by RV9.

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